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EVIDENCE OF EXTREME ROOT PROLIFERATION IN RESPONSE TO THE PRESENCE OF A NUTRIENT RICH RESOURCE PATCH BY *ERIOGONUM PARVIFOLIUM*

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ABSTRACT

I discovered evidence of extreme root proliferation by *Eriogonum parvifolium* following the recovery of skeletal remains of a large, radio-tracked snake buried in the sand dune environment at the Tijuana Estuary in San Diego, California. Located beneath an isolated *E. parvifolium*, the recovered remains were grossly entangled by a large number of roots generally absent from the adjacent soil. The apparent massive localized proliferation of roots suggests decomposition of the animal created a favorable soil mosaic readily utilized by the plant in an otherwise low nutrient environment.

Key Words: Root proliferation, *Eriogonum parvifolium*, nutrient patch, root growth response, resource heterogeneity.

A number of plant species show plastic growth responses when associated with the patchy distribution of resources (Robinson 1994; Hodge 2004). One type of growth response expressed when a plant encounters a nutrient rich patch of resources is the proliferation of lateral root branching (Hodge 2004). This can be massive in a region well supplied with a nutrient when the remainder of the root system is nutrient deprived (Robinson 1994). *Eriogonum parvifolium* Smith (Polygonaceae) is a woody perennial shrub common to stabilized sand dune formations in the coastal area of central and southern California (Purer 1936). In dune environments individuals of this species can attain 0.3 m to 1.0 m in height and 0.5 m to 2.0 m in spread with the taproot extending to a depth of 1.2 m and lateral roots spreading out two to three times as far as the parts above ground (Purer 1936; Hickman 1993). Sand dunes are low nutrient environments that show considerable resource heterogeneity (Hesp 1991). Living in the low resource environment associated with sand dune formations, *E. parvifolium* may show a significant root growth response following an encounter with a large nutrient resource. Here, I provide evidence of extreme root proliferation by *E. parvifolium* in response to encountering a rich resource patch, specifically a >500 g buried animal corpse.

In 2002, as part of a multi-year study on the space-use behavior of the Coachwhip Snake (*Masticophis flagellum*), I tracked 12 Coachwhips surgically implanted with radio-transmitters at the Tijuana River National Estuarine Research Reserve in San Diego County, California (32°34′N Latitude, 117°07′W Longitude, 0–6 m elevation; see Mitrovich et al. in press). The 1024 ha research reserve, bordered by the cities of Tijuana (Mexico) and Imperial Beach (USA), is a complex landscape with tidal marsh, alkali flats, fallow agricultural fields, riparian woodland, upland sage scrub, and sand dune habitats. The dune formations are limited to a narrow strip bordering the ocean and characterized by short dunes rarely reaching further than 125 m inland. The dunes lack trees and are largely vegetated by low-lying perennial plant species including *Abronia umbellata*, *A. maritima*, *Ambrosia chamissonis*, *Atriplex leucophylla*, *Calystegia soldanella*, *Camissonia cheiranthifolia*, *E. parvifolium*, and *Rhus integrifolia*.

On August 10, 2002 one of the radio-tracked snakes, a large, 1.13 m (snout-to-vent length), 560 g female, who had been active in the dune environment throughout the spring and summer seasons, was recorded using a rodent burrow located in a small, isolated dune partially covered by *E. parvifolium*. The use of a small mammal burrow as a retreat site is not uncommon for *M. flagellum*. However, this individual showed no movement away from the burrow the rest of the year through the spring of 2003. As a result of detecting no movement the following spring when all other tracked snakes were emerging from winter hibernation, I concluded the radio-tagged *M. flagellum* had died the previous fall or winter.

This was confirmed when I dug-up the remains of the animal with the still functioning transmitter on May 28, 2003, 290 days after the snake was first recorded as entering the burrow. I recovered the remains of the snake approximately 0.6 m to 0.7 m below the surface of the sand dune. The

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remains were located directly beneath a single, large *E. parvifolium*. The burrow had collapsed and the transmitter, although intact, was separated from the remains by several centimeters. Only skeletal remains were left. No soft tissue or skin of the animal was present. The snake's vertebral column was not complete as it was broken in several sections and not all sections were recovered.

Although the root structures of *E. parvifolium* were largely absent from the excavated soil removed during the digging process, a large mass of fine roots from the plant were entangled with the recovered segments of the vertebral column. The roots were so completely entwined with the vertebrae it was not possible to collect segments of the vertebral column without also harvesting roots. It appeared as though the roots entwining the skeletal remains were still connected to the root system of the plant. The way the roots had grown so tightly around the skeleton suggests the soil was nutrient-rich in the immediate vicinity of the animal's remains. As microbes in the soil broke down the animal tissue during the preceding months, the subsequent release of nutrients (e.g., N, P, Ca) was likely to be high and highly desirable by the plant, explaining a realized benefit behind the proliferation. Decaying vertebrate tissue is known to enrich adjacent soil horizons (Adl 2003).

Collectively the evidence suggests *E. parvifolium* responded to the resource-rich patch by increasing occupation of the immediate area surrounding the body. This evidence for significant root proliferation in *E. parvifolium* is not surprising given the environment (i.e., nutrient poor soils) where the response occurred. It is specifically in these nutrient poor soils where plasticity of root growth is expected to be most extreme following an encounter with a large resource patch (Robinson 1994). Clearly, the 500+ g animal corpse created a large organic input to the otherwise resource poor environment of the sand dunes. Plant-animal interactions are often categorized as mutualistic (e.g., pollination, seed dispersal) or antagonistic (e.g., herbivory; Gurevitch et al. 2006). Animal droppings are well known to contribute to soil quality mosaics that favor some plants' growth (Harper 1977). Creation of a favorable soil mosaic during decomposition is an additional benefit, albeit inadvertent.

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